initials, and determine morphological relationships merely by "how things look in the mature condition."

SERVIT extends VELENOVSKÝ'S "angular leaf" idea from pteridophytes to bryophytes, and describes such a leaf in Mastigobryum, where it is easily distinguished by its transverse insertion as well as by its form. It is situated at the base of two branches and he considers it as formed by the concrescence of the first leaf of both. This angular leaf, he says, is present in all liverworts whose branches arise from the half-segment; but it is elsewhere not so typical (this sounds Goethean) as in Mastigobryum. It is lacking in those whose branches arise only from the basiscopic part of the half-segment.

In intercalary branching both of liverworts and mosses the branch is endogenous and breaks through a sheath, which may be split into segments that SERVIT calls *Blättchen*. He has confirmed in all cases VELENOVSKÝ'S "law" (that the branches in mosses arise without exception in the axil of the leaf below them!) by examining "extraordinarily abundant material;" but he does not say that in any case he has determined the relation of the branch initial to the leaf initial. Until that is done the current view, which rests upon careful studies of LEITGEB, will prevail.

BUCH has made a thorough study of the two modes of vegetative propagation of *Blasia pusilla*,[13] especially of the development and germination of the gemmae produced in the flasklike receptacles. These arise both on male and female plants, but are rare on the latter if they form embryos. While the brood-buds (modified tips) are the chief means of propagation in summer, the gemmae probably do not germinate in the summer and certainly not in the autumn, but hibernate and start new plants in the spring. Shoots arise from either side (seldom both), where there is a zone of four small cells. One of the upper two produces a thallus initial by three successive divisions of the protruded tube, while the two lower ones produce rhizoids.—C. R. B.

Mutations of Oenothera.—MACDOUGAL[14] and his collaborators have published a further account of evolutionary studies upon the Oenotheras. Taxonomic descriptions of several of the mutants from *O. Lamarckiana*, as they grew in the New York Botanical Garden, are given, including *O. albida*, *O. oblonga*, *O. scintillans*, *O. brevistylis*, and *O. lata*. These will be valuable for comparison with cultures elsewhere. The English "*O. biennis*," as growing in the vicinity of Liverpool, has been found to be *O. Lamarckiana*, and growing wild with it are two of the mutants, *O. rubrinervis* and *O. lata*, the latter maturing pollen, contrary to its habit elsewhere. The cultures of *O. Lamarckiana* from DEVRIES' seeds gave six of the mutants described by that author and also nine other types which could

[13] BUCH, H., Ueber die ungeschlechtliche Vermehrung von *Blasia pusilla* (Mich). L. Öfvers. Finska Vet. Soc. Förhdl. **49**:no. 16. pp. 42. *pls. 2. figs. 7.* 1907.

[14] MACDOUGAL, D. T., VAIL, A.M. and SHULL, G. H., Mutations, variations, and relationships of the Oenotheras Carnegie Institution of Washington, Publ. no. 81. pp. 92. *pls. 22. figs. 73.* 1907.

not be identified. These aberrant forms are of special interest from the standpoint of variation, and it is hoped that further careful records will be obtained of them and their offspring.

SHULL presents a continuation of his earlier studies[15] on variation in *O. Lamarckiana* and some of its mutants. On account of the unsatisfactory character of height, branching, and leaf form for statistical comparisons, the studies are extended to include bud characters. The fact that all his collections of buds were made late in the season, and that there is a marked seasonal variation in the size of the buds, would render somewhat doubtful his statement that the periodicity is probably too small to need consideration. The bud characters chosen are length and thickness of ovary, hypanthium, and cone, the forms studied being *O. Lamarckiana*, *O. rubrinervis*, *O. gigas*, and *O. lata*. A formidable series of variation and correlation tables is presented, the general conclusion being that the mutants tend to show greater variability than the parent form, though there is no decrease in correlation of parts. MACDOUGAL concludes on these premises that instead of mutations being the cumulative results of ever-increasing fluctuation, they are the initial process, of which fluctuations in the mutants, gradually decreasing to a minimum, are an after-effect. The hypanthium of Oenothera, which is the most variable part of the bud, is considered an example of a phylogenetically new character showing increased variability.

Miss VAIL contributes taxonomic accounts of *O. grandiflora*, *O. Simsiana*, *O. Oakesiana*, *O. parviflora*, and *O. muricata*. *O. parviflora*, known in Europe since 1759, has recently been found native in Maine.

Cultures of *O. grandiflora* and *O. biennis* showed the presence in the former of at least two mutants, and that under the latter there is a swarm of elementary species distributed throughout North America. Two interesting cases of bud-sports were observed, one in *O. Lamarckiana*×(*O. Lamarckiana*×*O. cruciata*), and the other in *O. ammophila*, which is suspected of being a hybrid derivative of *O. biennis*. In both cases self-fertilized seeds of the mutant branch came true to the type of the sport.

A careful account is given of MACDOUGAL'S injection experiments. After some negative results with other forms, mutants were obtained from injected ovaries of *O. biennis* and *Raimannia odorata*. The solutions used were $ZnSO_4$ (1:500), $Ca(NO_3)_2$ (1:1000), and 10 per cent. sugar solution. Other inflorescences were treated with a pencil of radium emanations. In the *O. biennis* experiments, in addition to the usual forms, one rosette appeared which differed widely from any known type, and its progeny was like it. In the case of *Raimannia odorata*, a group of mutants appeared in the progeny of injected ovaries. It was also found that "plants of the progeny of the first treatment which were apparently normal yielded seeds which gave a few atypic forms."

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[15] MACDOUGAL, D. T., assisted by VAIL, A.M., SHULL, G. H., and SMALL, J. K., Mutants and hybrids of the Oenotheras. Carnegie Institution of Washington, Publ. no. 24. pp. 57. *pls. 22. figs. 13.* 1905.

BOULENGER,[16] from observations of the evening primroses growing wild at South Kensington, England, and in La Garde St. Cast, Brittany, concludes that *O. Lamarckiana* and *O. biennis* cannot be distinguished as separate "species," and that *O. Lamarckiana* originated from *O. biennis* through some hypothetical process of hybridization among the different forms of the latter. His conclusions rest on an examination of the variability of the plants taken *en masse* in the wild condition, and the unproven assumption that all the plants observed at St. Cast, Brittany, came from a single stock. Many different forms, both in Europe and America, go under the name of *O. biennis*, as MACDOUGAL has shown, and if *O. Lamarckiana* were capable of giving rise to any of these we might have expected to find them in DEVRIES' cultures. The study of the Oenotheras has long since reached the stage where cultures are necessary to determine the relationships of the various strains, and without such studies speculations drawn from casual observations of variability among forms growing wild are not likely to affect seriously the results obtained from culture work such as that of DEVRIES.—R. R. GATES.

A biometric study of Ceratophyllum.—A recent memoir by PEARL[17] on variation and differentiation in Ceratophyllum presents an admirable illustration of the successful application of mathematics to the working-out of important biological problems. The work is too compact to allow a brief review to present all the important relations which are clearly demonstrated by biometric analysis of the variation in the number of leaves in a whorl as related to the position of the whorl on the plant. It is shown that the whorls on each grade of branches, e. g., main stem, primary, secondary, tertiary, etc., are differentiated as a class from each other grade by several distinctive features of their variability. In all these grades the correlation between number of leaves in a whorl and its position on the stem is considerable. It is least in the main stem and increases as we pass to the more peripheral divisions. The regression line is not linear, but logarithmic, being of the type $y = A + C\log(x - a)$, in which A, C, and a are constants, y is the number of leaves per whorl, and x the position of the whorl. The curves so derived fit beautifully the observed data, and allow the derivation of what is believed to be a very fundamental biological law which is called the "first law of growth" in Ceratophyllum, and is stated thus: "On any axial division of the plant the mean number of leaves per whorl increases with each successive whorl in such a way that both the absolute increment and the rate of increase diminish as the distance (measured by the number of nodes) of the whorl from a fixed point increases."

By the fact that the equation fits data from plants collected from different habitats, by merely changing the factor A which represents the actual size and

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[16] BOULENGER, G. A., On the variations of the evening primrose (*Oenothera biennis* L.). Jour. Botany **45**:353–363. 1907.

[17] PEARL, RAYMOND, assisted by OLIVE M. PEPPER and FLORENCE J. HAGLE. Variation and differentiation in Ceratophyllum. Carnegie Institution of Washington, Publ. no. 58. pp. 136. *pls. 2. figs. 26.* 1907.